Volume 20 July, 1943 *Number 7*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Rust Prevention

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

SETTING this huge prefabricated stern section in place typifies the mass-production methods used in wartime shipbuilding. Today, not only ship sections, but engines and parts, guns and mounts, etc., are fabricated at distant points for assembly at the shipyard. En route, they must be protected against rust and corrosion.

To rustproof metal not only in shipyards, but on farms, in construction work and throughout all industry, property owners everywhere are protecting exposed metal surfaces with *Texaco Rustproofs.*

Although *Texaco Rustproofs* penetrate existing rust, and prevent further deterioration of the sound metal underneath, it is highly desirable to remove all scale and paint before brushing or spraying on these remarkable new products.

A Texaco Lubrication Engineer will gladly help with any rustproofing problem. Just phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write The Texas Company, 135 East 42nd Street, New York, N. Y.

TEXACO

TEXACO Rustproof Compounds

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Change of Address: In reporting change of address kindly give both old and new addresses.

Rust Prevention

RUST prevention has concerned industry ever since the Age of Mechanics predicted the modern Era of Mass Production. Rusting of iron and steel has always meant loss of material as rusted surfaces changed from their intended structure. Whenever this occurs, the precision to which the surfaces were originally machined is destroyed; rust particles sometimes chip off to further destroy other surfaces, such as the surfaces of bronze bearings; and rust, like a malignant disease, can prevent protection of the sub-surface so that this in turn can be destroyed.

The cost of rusting has been estimated in various ways; in terms of per cent of amount of the material involved; in terms of the effect on other materials; in terms of the labor lost in initial manufacture; or in terms of the scrap value.

Research has resulted in the development of highly satisfactory materials for rust prevention, products which are eminently suited for various types and length of service required. Most of these products are of petroleum base. The petroleum technologist, in cooperation with Industry, has developed the solution to most of the problems of rust prevention which are of so much concern today in connection with the war effort.

The rust preventives available for the purpose of keeping steel from rusting can be grouped under four broad classifications, i.e.,

Straight Petroleum oils
Special rustproof oils
Heavy non-drying compounds
Hard drying coatings

Each has a definite field of service, according to the size, shape or nature of the material to be protected, the nature of protection desired and the facilities for application.

In any event it is too high a cost to pay for an unwanted chemical reaction which can be obviated by intelligent use of a suitable rust preventive during the course of forming iron and steel materials, during storage of the finished product, or while the latter are in service.

Rust is even of more vital concern to industry today, as American equipment must be so widely distributed to the various theatres of war.

WHY RUST IS OBJECTIONABLE

1. Rust changes the size of steel parts.

Quite naturally, this must not occur, otherwise the precision of the entire machine may be affected. Rust is a detriment because it slows up production, for machinery built of precision parts cannot use rusted parts where the size might be affected by even a thousandth of an inch due to rust.

2. Rust reduces the strength.

This is highly important when rust of structural steel has occurred sufficiently to weaken the load carrying capacity.

3. Rust affects the ability of steel to take paint, lacquer or enamel.

In the steel industry, it is especially important to prevent rusting after the sheets have been rolled, and during the time they are being stacked, packaged, and delivered to the consumer. Otherwise the steel in question may be returned to the mill as not acceptable due to inability to be used in subsequent operations such as painting, enameling, etc.

4. Rust is unsightly.

Accordingly, it will reduce the sales value of iron or steel articles affected, even though it may have no material effect upon the size, strength or even the performance of the article in question.

It is obvious that conservation of material requires rust prevention while steel is in the formative stage as well as after the finished parts have been assembled.

HOW RUSTING DEVELOPS

The chemistry of rusting is known to all who have studied elementary inorganic chemistry. Fundamentally, it is a process of more or less rapid oxidation depending upon the severity of the oxidizing influences. The most usual contributing factors are—

(a) Oxidation in the presence of excessive humidity

(b) Corrosive chemicals in the atmosphere, and

(c) Stray electric currents.

Regardless of the quality of whatever rust preventive material may be used; it is obvious that poor application, or careless handling of the rustproofed article, may result in rusting due to the fact that oxygen and moisture have been allowed to contact the surface.

Moisture and air must be present for most types of rust to develop. Rust is usually reddish-brown in color, although sometimes, especially between sheets of oiled steel, it may assume a vari-colored hue when chemical reactions other than oxidation are involved. Stray currents usually result in pitting which may or may not be accompanied by other forms of rust.

Types of Rust

The various types of rust which can form on steel surfaces can be cataloged according to appearance. An experienced steel man usually can determine the cause of rust formation by the peculiar design which the rust assumes, and is able to correct the conditions which are at fault.

I—Red Rust due to Oxidation and Moisture

This type of rust is generally found on any unprotected steel surfaces which have been exposed to oxidizing influences for any length of time. It may develop in the storage yard, in the store room or while materials are being shipped or used if no rust preventive coating has been applied. In the steel industry this type of rust can occur on sheet steel, the surfaces of which have received no protection or inadequate protection from an unsuitable type of rust preventive.

When the protecting film is inadequate, rust forms on the parts, aggravated by the excessive temperature variations which cause moisture condensation, prevalent in unheated steel mills.

Red rust will occur on any steel surface which has been exposed to moisture without proper drying immediately thereafter. It may result from contact of steel parts machined with soluble oil. It may be caused on sheet steel where water has been used for cleaning purposes. It may occur where drops of water which have accumulated on overhead structures have fallen onto the steel.

Even though heavy compounds have been used for the protection of articles, red rust can occur if the compound has been carelessly applied or the film removed by exposure to rough handling. This type of rust is particularly liable to occur under exposure to salt water.

II—Rust due to Corrosive Chemicals

This type of rust may be vari-colored according to the type of chemicals involved. Normally, the steel is not intentionally exposed to corrosive chemicals. Such exposure results from chemical vapors in the air which are unavoidable.

Acidic atmospheres are frequently encountered in steel mills and some other industries, and are a common cause of this type of rust. Acidic influences may also develop from material used during the course of processing or assembly.

After the pickling operation, if thin streaks of salt remain on the steel after a lime dip, even though the steel surface may be dried by heating, these salts will tend to retain or will absorb sufficient moisture to cause rust formation directly under the streaks of salt.

Yellow streaks will sometimes be found on steel which has been stored for some months. These may be caused by the corrosive action of some fatty acid which has resulted from improper use of fatty material in a rust preventive. Marks of this type are difficult to remove. If they are on steel stock which is to be enameled white, they will show through the enamel coating.

Mineral acids also may cause rust of a grayish, cloudy nature. This type of rust has been noticed on steel coils within a few hours after they have been slushed with unsuitable or inferior materials.

Pin points of rust can occur due to inadequate cleaning of steel which has resulted in leaving small specks of scale or slag on the surface. They may result in minute rust spots, even though covered with a rust preventive material which would have been adequate for properly cleaned steel.

Fig. 1—An "island" type of rust due to presence of moisture on a bare spot between sheets of oiled steel.

Fig. 2—An example of rust caused by finger prints.

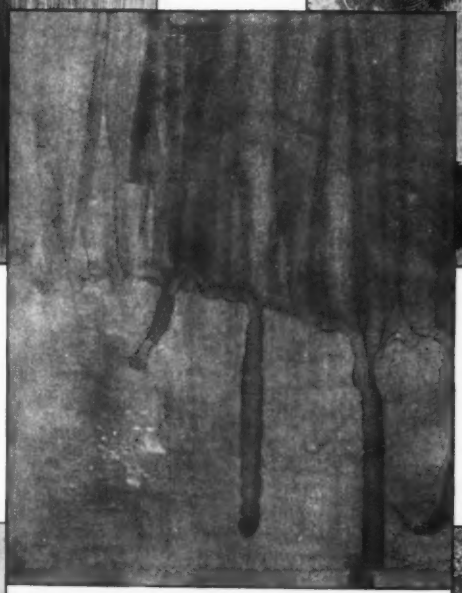


Fig. 3—Another type of rust streaking due to acid or water on the sheets during rolling.

Fig. 4—Showing how yellow rust streaks appear. Caused by presence of fatty acid.

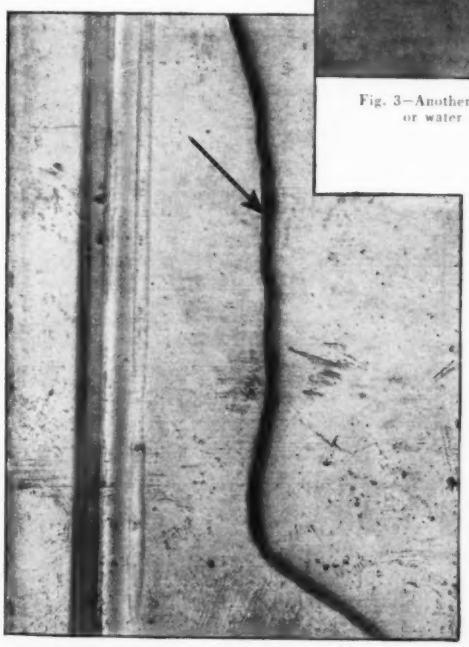
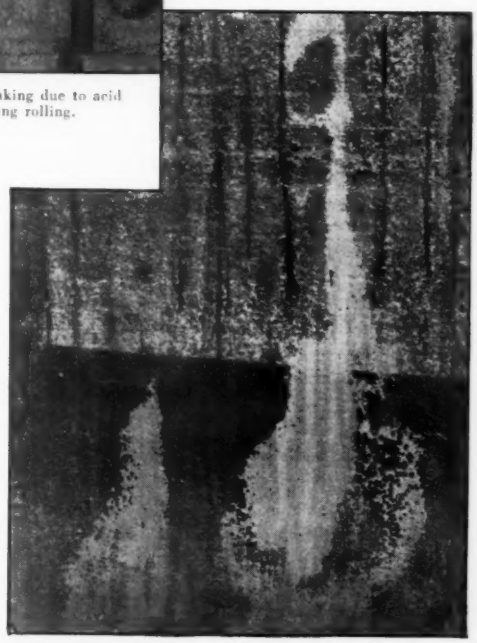


Fig. 5—An example of rust streaks due to salt left on the steel.



SHOWING SOME OF THE MOST COMMON TYPES OF RUST

Fig. 6—Showing a steel girder. A typical example of rusting of exposed surfaces.

Finger prints can also be the cause of chemical reaction on the surface of steel. When such prints are not completely removed, rusting is inevitable. They can be removed by washing with caustic or sodium phosphate, or may be avoided by handling steel articles with clean cotton gloves.

III—Electrolytic Corrosion

Stray currents are occasionally found in assembled machines or pipe lines. Rusting caused by these currents results in definite pitting at the point where the current leaves the metal. This can occur in the absence of oxidation and is usually readily identified.

METHODS OF RUST PREVENTION

It is obvious that the ideal is to prevent rusting from the beginning throughout the life of the material. This requires protection of steel surfaces from the time they are run through the final stage of forming in the rolling mill, to the time they are discarded as junk. The most critical stage in the life of a steel surface is when it first cooled to room temperature. It is probably cleaner chemically at this time than it ever will be afterwards, and is most susceptible to oxidation and rusting. At the same time the atmospheric conditions which promote rusting are often most pronounced. As rusting of iron or steel is the result of oxidation at normal temperatures in the presence of moisture, high humidity conditions will accelerate this reaction. It is obvious that any means which will eliminate contact of both air and moisture with the surface will effectively prevent ordinary rusting.

The main function of rust proofing materials, therefore, is to prevent this contact. A limited amount of protection can be provided for materials in storage by mechanical control of humidity and temperature. In fact, if the surfaces of iron or steel materials can be kept absolutely dry, rusting is virtually impossible, for moisture must be present to complete the oxidizing reaction which leads to rust.

Four general methods of rust prevention can be followed:—

1. Using rust-resistant metal such as stainless steel.
2. Controlling rust-forming influences, viz:—
   (a) regulating the humidity,
   (b) eliminating contact with corrosive chemicals, and
   (c) eliminating all stray electric currents.
3. Chemically changing the surface of the steel.
4. Protecting the metal with suitable coatings such as
   (a) metal plating,
   (b) use of hard-drying paints, or
   (c) non-drying petroleum-base materials.

Permanent structures are usually coated with either a hard-drying paint or a petroleum-base material. Sheet steel in storage or in transit is most often protected by some type of oil. Steel machined parts are most often coated with heavier petroleum compounds which can be removed without too much trouble, when necessary.

This procedure is the most practicable in the majority of cases where steel parts must be handled or transported. Humidity control is very effective in storage or in a plant but obviously it is impractical the moment the parts are moved into the outdoor atmosphere.

Humidity control cannot function when water is used in processing; i.e., when water must be used in the preliminary preparation of the bulk materials, as in the rolling of steel. Later, moisture may be present due to incomplete drying or to condensation, especially in a humid atmosphere when normal temperature drop takes place.

Moisture is especially likely to be present when any drying operation is carried out by direct contact with live steam. Under such conditions a final treatment of the parts with hot dry air will effectively remove any final traces of moisture. Condensation can be restricted by keeping metallic parts warmer than the surrounding air.

In any even complete drying is desirable prior to application of a rust-preventive material.

Application of Rust Preventives

In the steel mill rust preventive oils are frequently applied with felt rollers after the last rolling and cleaning operation. Steel parts are usually dipped in rust preventive oils after every machining operation; parts too large for this procedure can be coated by brushing or spraying.

Heavier types of compounds are applied according to their consistency. The lighter grades can be brushed, swabbed, or sprayed. The heavier grades, however, require heating. They are particularly suitable for dipping where relatively permanent protection is desired. The hard drying coatings are handled in the same manner as ordinary paint.

Studying the Causes

If rusting has occurred in spite of the use of some rust preventive material, a complete investigation should be carried out in a logical and orderly manner. A suggested method of procedure follows:—

1. Obtain samples of the original unused rust preventive for laboratory analysis to determine if any moisture or other contaminant is present.
2. Obtain samples of rust preventive from the steel involved, also samples of the steel showing rust or other deposits. A laboratory analysis of the rust preventive and of the deposit will usually indicate the cause.
3. Observe the processing to which the steel has been subjected prior to application of rust-proofing. Observe the storage and shipping conditions after the steel has been coated; look for atmospheric condensation or contact with moisture during course of handling.
4. Observe methods of handling the rustproof materials. Careless handling often may cause an otherwise satisfactory rustproof material to become contaminated.
5. Set up rusting tests in the plant using the steel and rust preventive material under investigation. These tests can be accelerated if desired.

Fig. 7—A bridge support before rust-proofing.

6. Study the findings of the above in connection with the different types of rust and corrosion commonly found on steel surfaces.

DEVELOPMENT OF RUSTPROOFING MATERIALS

Four distinct types of petroleum base rust-proofing materials are available:

1. Straight Petroleum Oils
2. Special Rustproof Oils
3. Heavy Non-Drying Compounds
4. Hard Drying Coatings

Straight Petroleum Oils

These products are usually well-refined lubricating oils containing no fatty oils or other added materials. Either paraffin or naphthene base oils can be used with good results. Light oils having a viscosity of from 85 to 250 seconds Saybolt Universal at 100 F. are used chiefly for the temporary protection of sheet steel. They furnish good rust protection and lubrication between steel sheets in stacks, although plant observations have shown that they do not give complete protection to the steel against rusting in the presence of moisture. Water coming in contact with the steel, even after it has been oiled, will tend to penetrate a straight mineral oil film, wet the surface, and cause rusting, often in a few hours. Because of the limitations of these oils special products are

Fig. 8—A method of cleaning structural steel, also applying compound by spraying.

necessary for many purposes. The protection afforded by straight mineral oils to sheet steel is limited to locations where rusting conditions are not severe and where the steel can be protected against atmospheric condensation due to extreme temperature changes.

Straight mineral oils of various viscosities are also used for many general rust-proofing purposes. It is usually true that the heavier the oil the better the protection, although no straight mineral oil can be expected to give satisfactory longtime rust prevention.

Special Rustproof Oils

These products are composed chiefly of petroleum lubricating oils with or without volatile thinners, to which have been added smaller amounts of other protective materials. When a thinner is used it acts merely as a solvent which reduces the viscosity and aids in uniformly spreading a thin layer of the rust-preventing material. The special rust-proofing oils will range from very light viscosity, around 35 seconds Saybolt Universal at 100 Fahr., up to very heavy grades of cylinder stock.

Certain materials, of non-petroleum nature, if present in necessary pre-determined quantities and if prepared in the proper manner, will add to the rust-proofing qualities of petroleum oils. The selection of these additives has been the result of a vast amount of careful research which has been necessary to insure the maximum effectiveness and eliminate all possibility of detrimental materials being used.

Fatty oils give increased adhesiveness to the oil. They also tend to form emulsions with any moisture that may be present, thus keeping the water from wetting the steel, thereby preventing rust. Certain fatty oils, however, upon long contact with metal are not entirely stable. They tend to oxidize, forming fatty acids which are definitely harmful. The selection of these oils, if used, is therefore of extreme importance.

Where thinners are used, their flash point should be sufficiently above room temperature to minimize any possibility of fire hazard.

Special rustproofing oils are particularly useful where storage conditions are poor, where steel is exposed to atmospheric temperature changes, and when shipments are to be made in winter when extreme temperature and humidity changes take place, causing steel to "sweat". They are not intended for protection under outdoor atmospheric conditions, although the better grades will give limited protection. When they have been developed as a result of adequate and careful research, they will give long-time protection to steel which is not exposed directly to the elements, and will give very much better service than a straight mineral oil.

Heavy Non-Drying Rustproof Compounds

This group includes those special petroleum compounds which are relatively viscous and non-hardening, but can be applied with a brush or heated for dipping. They produce a self-healing, non-hardening film that is waterproof and therefore capable of effectually preventing rust. Some of these materials are also capable of penetrating existing rust to prevent further deterioration of the metal underneath. Most of these compounds can readily be removed with a solvent such as kerosine.

These compounds are especially suitable for steel which is to be stored or shipped under unfavorable weather conditions. They are also suitable for the protection of steel structures such as bridges, farm equipment or any steel which is directly exposed to the elements.

Investigation of the composition and rust-preventing ability of many of these compounds has been the basis of some very interesting research recently. They were studied from the standpoint of basic service requirements which call for:

1. Ease of application.
2. Maximum protection of the surface against contact with air and moisture.

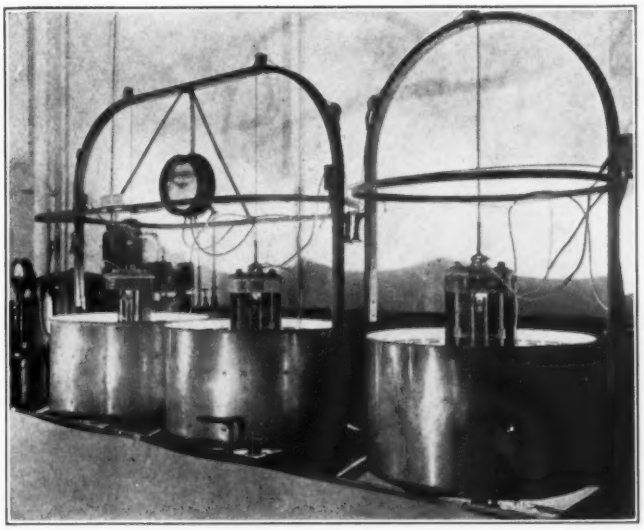


Fig. 9—Accelerated weathering test apparatus.

3. Easy removal when this protection is no longer required.
4. The safety factor.

Ease of Application

In order to establish the optimum characteristics for application, not only actual consistency but spreadability, wetting properties, surface tension, penetration and other factors had to be studied. The products resulting can be applied by hot dipping, brushing, or spraying, with maximum ease and economy. Many different additive materials were found to be required to accomplish these results.

Inasmuch as film thickness is contingent upon ease of application and is definitely related to consistency and temperature, some laboratory data developed on one of the outstanding non-drying rustproof compounds is of interest. The method of procedure involved immersion of steel plates of uniform size in the material at predetermined temperatures for one second and thirty second periods. The following data are significant:

FILM THICKNESS ON 1/8" STEEL PLATE

Temperature of Rustproof Compound Bath	Temperature of Steel Plate and Immersion Time	
	77° Fahr. 1 second	85° Fahr. 30 seconds
150°F.	0.039"	0.007"
175°F.	0.019"	0.005"
200°F.	0.018"	0.004"
225°F.	0.018"	0.004"
250°F.	0.018"	0.003"

Objects, dipped when cool, or for an insufficient length of time may be coated too heavily. Objects dipped for too long a time at too high a temperature may be coated too lightly. In other words, the film thickness depends on the size and temperature of the object to be coated, the temperature of the bath and the time of immersion.

The lighter grades of these compounds can be applied by brushing or swabbing at ordinary summer temperatures. The heavier grades are frequently cut back with a solvent to enable brush application. Most of these products are readily diluted with petroleum solvents to a consistency suitable for spraying if desired. Evaporation of the solvent leaves a residual rust protecting film of the same quality as obtained by hot dipping.

Where a rustproof compound is to be applied over existing rust (without chipping to fresh metal) a thicker than usual application is necessary because some of the rustproof compound must penetrate the rust layer. Then it can function most effectually as a preventive of further rusting. On the other hand, wherever time and labor facilities will permit, extremely heavy rust scale should be chipped off before the metal is treated.

Maximum Protection

In order to secure maximum protection it must be remembered that the thicker the film the better the protection. Thin application or thin spots in thick applications will not give the

Fig. 10—Details of an accelerated weathering test machine.

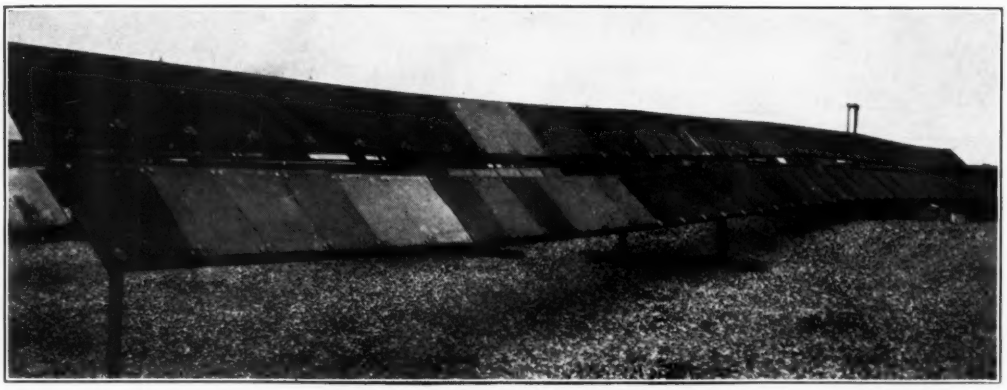


Fig. 11—Weathering tests by exposure to the elements.

best protection. Excessively thick applications of the lighter compounds are apt to be removed by dripping at excessively high storage or service temperatures. Thick applications of the harder compounds are quite difficult to remove. Smooth, uniform, moderately thick applications are therefore very desirable and will afford the maximum protection for the longest time. The best grades of these compounds, when properly applied, will protect steel articles exposed to severe atmospheric conditions for a year or more.

In order to develop products which will give the service desired from this type of product, a large amount of work has been done by the petroleum technologist. This work has covered a number of accelerated weathering tests, 100% humidity tests, salt spray tests and heat tests as well as actual outdoor weathering tests conducted on experimental decks at various parts of the country. As in the case of special oils, a number of useful additive materials have been found which are being used in this type of product which greatly improves the protective value.

Ease of Removal

On account of the necessity for removal of rustproof compounds from many pieces of equipment before placing in service, easy removal with readily available petroleum solvents such as kerosine is considered most necessary. Tests for removal were therefore carried out on coated specimens after exposure to severe service conditions. Most of the products on the market are quite satisfactory in this respect.

The Safety Factor

Safety in handling of any type of rust preventive must always concern the user. Wherever heating is necessary to reduce the fluidity sufficiently to permit dipping, swabbing or spraying, the flash point of the product should be well above the maximum temperature to which it must be heated. Quite naturally, the heavier the product, the higher the pre-heat temperature may have to be. In the case of materials applied cold, which contain solvents, the flash point should be above 100° Fahr.

Because of the non-drying nature of these materials it should be recognized that they are not safe for use under foot since they are apt to be slippery.

Hard Drying Coatings

Such materials are usually designed for semi-permanent coverage of outside steel surfaces for extended periods of time. Normally, they involve paints or non-oxidizing asphaltic cut-back materials. Paints may or may not contain pigments. Hard drying coatings usually contain thinners to facilitate application. When these thinners evaporate, a hard tough surface results which is more or less resistant to wear and weather. The expected length of protection afforded by these materials will vary widely according to type and source.

CONCLUSION

By reason of the extensive amount of research which has been devoted to this matter of rust prevention by the Petroleum Industry, the problem is changing from one of development to one of application. In other words, a sufficiently wide range of rustproofing materials are available to assure protection for every type of service. The War has speeded the development of products and methods of application which are constantly being improved. It is only necessary to select and apply the correct rustproof material for the protection required.

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SALLEY & COLLINS, INC.
305 East 45th Street, New York

TEXACO RUSTPROOF COMPOUNDS FOR THE PROTECTION OF IRON AND STEEL

TEXACO RUSTPROOF COMPOUND H

A relatively viscous, non-hardening, high flash point material, of smooth, soft and tacky consistency. Easily applied by dipping or spraying at 175°F. Produces a soft, self-sealing, penetrating film which is waterproof. Readily removed with a solvent such as kerosine if desired.

TEXACO RUSTPROOF COMPOUND L

Derived from Texaco Rustproof Compound H by thinning with solvent. It can be applied at room temperature with a brush, is semi-transparent in thin films, and penetrates existing rust to prevent further deterioration of the metal underneath.

TEXACO RUSTPROOF COMPOUND LB

A product similar to Texaco Rustproof Compound L, except that it is black in color.

TEXACO 1946 RUSTPROOF

Has a consistency similar to a soft wax. Usually applied by brushing. It contains a solvent which evaporates, leaving a dark, heavy, tacky film which gives excellent protection for either indoor or outdoor exposure.

TEXACO NO. 1234 PETROLATUM

This product has a consistency similar to a soft cup grease. It can be applied by brush or, if heated to its melting point (about 135°F.), steel can be coated by dipping. It will give excellent protection for either indoor or outdoor exposure.

TEXACO 1231 PETROLATUM

A somewhat more tacky product than Texaco 1234 Petrolatum. Has a minimum melting point of 150°F. Can be applied by brush, or by dipping the steel to be protected, if heated above the melting point. Stands weather exposure very well.

TYPICAL TESTS ON TEXACO RUSTPROOF COMPOUNDS

	Rustproof Compound H	Rustproof Compound L	Rustproof Compound LB	1946 Rustproof	1234 Petrolatum	1231 Petrolatum
Color	Greenish-Brown	Greenish-Brown	Black	Dark Green	Green	Green
Pounds per gal. @ 60° F.	7.60	7.26	7.30	7.31	7.453	7.495
Penetration @ 77° F. (Unworked)	140	270	260	235	340	59
Flash (Cleveland Open Cup) °F.	440	135	140	190	425	500
Softening Pt. (Petrolatum Method)	142	129	130	135	135	152
Thinner, %	0	24	24	29	0	0

For America's Bread Basket

THESE tractor-hauled combines are cutting, threshing, depositing the grain in the motor trucks, leaving behind the sheaves of straw. Due to food rationing and manpower shortages, it is more important than ever to conserve such farm machinery when idle by protecting it against rust and corrosion.

To rustproof machinery not only on the farm, but in the construction field and throughout all industry, owners everywhere are protecting their equipment with *Texaco Rustproofs.*

Although *Texaco Rustproofs* penetrate existing rust, and prevent further deterioration of the sound metal underneath, it is highly desirable to remove all scale and paint before brushing or spraying on these remarkable new products.

A Texaco Lubrication Engineer will gladly help with any rustproofing problem. Just phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write The Texas Company, 135 East 42nd Street, New York, N. Y.

TEXACO

RUSTPROOF COMPOUNDS

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